Ubiquitous Fast Propagating Intensity Disturbances in Solar Chromosphere

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Abstract

High cadence observations by the slit-jaw (SJ) optics system of the sounding rocket experiment "the Chromospheric Lyman Alpha SpectroPolarimeter (CLASP)" reveal **ubiquitous intensity disturbances that recurrently propagate in either the chromosphere, transition region, or both at a speed much higher than the sound speed (Kubo et al. 2016, accepted).**

CLASP Slit-jaw (SJ)

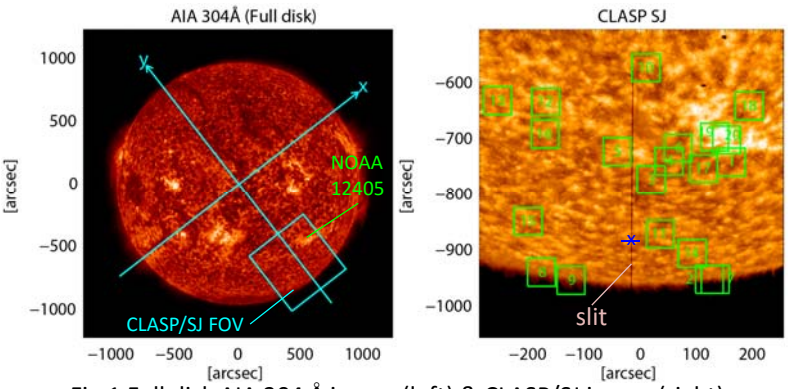


Fig.1 Full disk AIA 304 Å image (left) & CLASP/SJ image (right)

Summary of CLASP/SJ observations			
Field of view	527" x 527"	Pixel scale	1.03"
Duration	280s	Cadence	0.6s
Wavelength	Lyα (121.567nm)	Bandpass	7nm (FWHM)
Obs. layer	Middle or upper chromosphere		

Case 1: Edge of AR

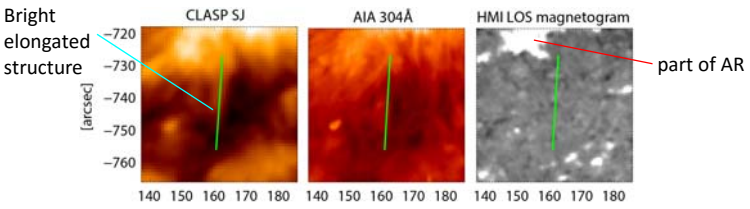
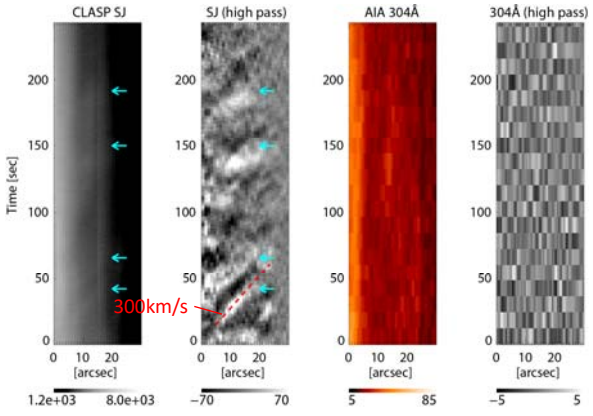


Fig.2 Images averaged over the observing period in Box 1 (Fig.1)



High pass filtered plots are made by subtracting the slow-varying components (~30s running temporal average) from the original time profile.

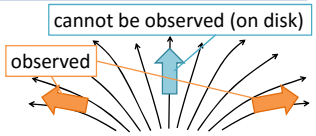
Fig.3 Space vs. time plots along the green line above

- The intensity disturbances move away along the bright elongated structure from the active region at ~300 km/s in the high-pass-filtered CLASP/SJ images.
- The time scale of each intensity disturbance is < 20s.
- No clear propagating pattern is observed in the AIA images.

Statistical properties

The multiple fast propagating intensity disturbances are clearly detected at least in 20 areas (green boxes in Fig.1) during the 5-minute observing time.

Properties of events in 20 areas			
# of repeats	> 2	Region	QS, AR
Speed	150 - 300km/s	Timescale	< 30s
Amplitude	2 - 5%	Distance	5" - 10"
Width	2"- 3"	Brightness	Along bright threads
Direction	Away from magnetic concentrations		



- The observed fast propagating intensity disturbances are related to the magnetic canopy structures.
- The apparent propagation speeds are much faster than the typical sound speed (~20 - 50 km/s) in the chromosphere or the transition region. They are comparable to the local Alfven speed in the transition region. → MHD phenomena
- The timescale is much shorter than quasi-periodic propagating intensity disturbances with periods of several minutes that are interpreted as slow propagating magneto-acoustic waves.

Temporal evolution of Stokes I profile

CLASP simultaneously obtained Stokes-I profiles of Ly-alpha line (121.6nm) and Si III line (120.7nm) at 0.3s cadence.

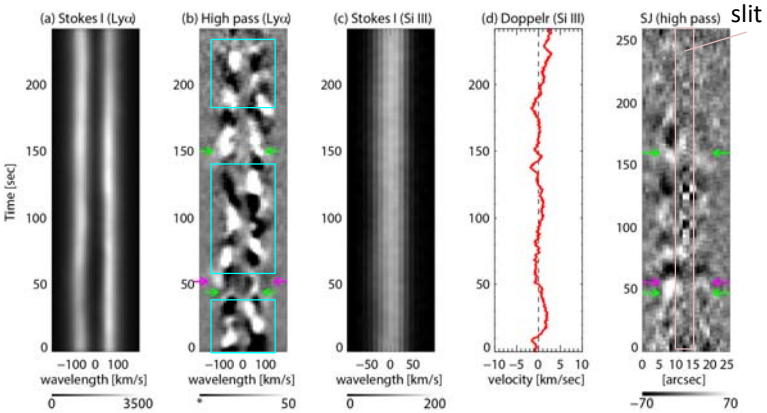
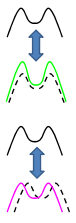


Fig.4 Temporal evolution of Stokes I profiles at "X" of Fig.1 for (a) Lyα, (b) high-pass-filtered Lyα, & (c) Si III lines. (d) Doppler velocity. (e) Space-time plots of high-pass-filtered SJ along the blue line of Fi.g1

- The weak intensity enhancements of the entire Lyα line profile are observed during the intensity disturbances pass across the slit (green arrows).
- No significant Doppler shift > 150km/s in Lyα or Si III lines is observed during the fast propagating intensity disturbances in SJ images.



→It suggests that SJ fast propagating intensity disturbances correspond to apparent pattern motions (waves or oscillations). One possible explanation for the fast propagating intensity disturbances observed by CLASP/SJ is MHD fast mode waves.

- It is also found that antisymmetric changes of blue and red peaks of Lyα lines alternately and recurrently appear in the short timescale in the period without the propagating intensity disturbances (sky-blue boxes).